First midterm exam of Chem 336

Date: 04/11/2025 - Allowed time: 90 minutes

Answer all the following questions and be sure to give <u>at least 3 significant figures</u> for any numerical answer and the <u>appropriate unit</u>.

1. We mixed 109.0 mL of pure ethanol (0.789 g/mL) with 80.8 mL of pure water (0.998 g/mL) at room temperature (25 °C). Calculate **<u>for the ethanol</u>** in this solution:
   a) The percentage by volume.
   b) The percentage by mass.
   c) The mole fraction (X_{eth}).
   d) The total volume of the solution by using the partial molar volumes of ethanol and water given below.

X_{eth}	0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
V_{eth} / mL mol^{-1}		53.1	55.36	56.4	57.1	57.5	57.87	58.1	58.3	58.5	58.63
V_{wat} / mL mol^{-1}	18.07	18.11	17.67	17.3	17.01	16.8	16.21	15.9	15.75	15.7	

2. At 25 °C, the density of a 52.3 per cent by mass ethanol–water solution is 945 kg m^{-3}. Given that the partial molar volume of water in the solution is 17.3 cm^3 mol^{-1}, calculate the partial molar volume of the ethanol.

3. The total volume (in **cm^3**) of a liquid solution of A in B is expressed as function of the number of moles of A (**x**) by the following equation:
   $V_T = 32 + 3.5\ x + 0.75\ x^2$
   Given that the number of moles of A and B are 1.5 mol and 3.5 mol respectively, what are the partial molar volumes of A and B?

4. A container is divided into two equal compartments. One contains 4.5 mol H_2(g) at 25°C; the other contains 1.5 mol N_2(g) at 25°C. Calculate $\Delta_{mix}G$ and $\Delta_{mix}S$ when the partition is removed. Assume perfect behavior.

5. We mixed 3.7 mol of ***A*** and 2.7 mol of ***B*** at 25 °C. Given that the total Gibbs free energy of this mixture is expressed as below:
   $G_T = 3.5 + 0.45\ n + 0.15\ n^2$, where **n** is the number of moles of ***B***.
   Calculate:
   a) the total Gibbs free energy of this mixture,
   b) the chemical potential of B at 25 °C in this mixture,
   c) the chemical potential of A at 25 °C in this mixture.